Chapter 8 Review Questions Answer Key

1. Who invented the first camera? The first CRT? When were these discoveries made?

   A: The first camera for photography is credited to Loui Daguerre, a French inventor, who created the Daguerreotype camera in 1839. This was followed by the first cathode ray tube scanning device invented in 1897 by German scientist Karl Ferdinand Braun, who called it the cathode ray oscilloscope.

2. What is Oleg Vladimirovich Losev's claim to fame?

   A: Russian researcher Oleg Vladimirovich Losev published a series of papers from 1924 to 1930 that detailed a comprehensive study of the LED and its applications and described its use.

3. Who invented the complementary metal-oxide-semiconductor?

   A: On the hardware side; in 1963 C. T. Sah and Frank Wanlass published a conference paper that introduces the CMOS principle to the world, a principle that Wanlass would later patent and RCA Research Laboratories would first produce.

4. Who invented the charge-coupled device?

   A: In 1969 Willard S. Boyle and George E. Smith invented the CCD which stands for charge-coupled device and was made up of pixels constructed of metal-oxide semiconductor (MOS) capacitors that converted the light photons falling onto them into electrons.

5. What does the Bayer filter do?

   A: In 1974 Bryce E. Bayer created the Bayer filter mosaic that enabled a single CCD or CMOS sensor to capture any color, thus negating the need for dedicated color

pixels. The filter pattern is 50% green, 25% red, and 25% blue to mimic the way our eyes perceive color and is the basis of filters we still use today.

6. What are the main components of a vision system?

   A: We can break most vision systems down into the following basic components:

   - Imaging device
   - Lens
   - Processor
   - Communication
   - Light source
   - Extras

7. Which kinds of technology have been used in the past in vision systems to capture images? Which kinds of technology are used today?

   A: We have used CRT, Vidicon tube, CCD, and CMOS technology to capture pictures, but today most vision systems will use either CMOS or CCD technology with CMOS quickly becoming an industry favorite.

8. What is the difference between line scanning and area scanning?

   A: With 1D, or line scanning**,** the imaging device uses a single line of CCD or CMOS element to gather the picture. This system works well with metals, non-woven items, paper, and plastics. With 2D, or area scanning**,** the imaging device has an array of CCD or CMOS elements giving the system the ability to take a picture of an area or object all at once.

9. How can vision systems create 3D images?

   A: We can create 3D scans by using multiple cameras to take pictures of the same object and then processing that data through special algorithms. We can create 3D images with only one camera, but we either have to take multiple pictures of the object from different locations or slowly move the object while using a laser to illuminate it. With the laser method, we create a cloud of points in space that are then stitched together by system software.

10. What is the importance of the focal length of a lens?

    A: Once we find the focal length we must ensure that the working distance is greater than this, or the lens will not transfer the image to the sensing unit correctly.

11. What does the imaging system processor do?

    A: The imaging system processor is the portion of the vision system that takes the raw data from the sensors, usually in the form of voltage or current, and converts it into a digital signal that other controllers can use one frame or picture at a time.

12. What is the difference between edge detection and clustering?

    A: Edge detection is the process of data sorting where the processor looks for sharp differences in the light values between elements or pixels and then uses the elements nearby to confirm that it has indeed found an edge. Clustering, sometimes knows as region growing, sorts data by finding elements that have similar value and growing the clusters outward from there.

13. What are some of the features we might look for with edge and region statistical matching?

    A: • Center refence point from which all other points are described

- Major part axis
- Minor part axis
- Number of holes
- Angular feature relationships
- Perimeter squared divided by the area, which creates a unique mathematic value that is not affected by scale
- Object texture data

14. Which of the lights covered in this chapter can be strobed?

    A: Xenon, LED, and Laser

15. Which of the lights covered in this chapter generate large amounts of heat?

    A: Incandescent, Halogen, HID, and Xenon

16. Which type of light is the go-to light for many vision applications? What are the pros and cons of this type of light?

    A: LED. LEDs are inexpensive to create, emit specific colors of light, and consume very little power during operation. They run cooler than HID, incandescent, or halogen lighting systems and you can strobe LEDs if needed. On the downside, LEDs are less dependable at temperature extremes, they can generate enough heat to damage their semiconductor material and may require heat sinks or fans to cool them. If the cooling system fails there is a high probability of LED damage and their light will degrade over time.

17. What does the term *laser* stand for? How do lasers operate?

    A: Laser is actually an acronym for the working principle of the system: Light Amplification by Stimulated Emission of Radiation. Lasers intensify light by

circulating light between two mirrors, one curved and one flat that is partially reflective, known as the laser resonator, and then amplifying it through the use of a gain medium.

18. What is the difference between bright field lighting and dark field lighting?

    A: Bright field lighting involves using a lighting system where a large portion if not almost all of the light from the illumination source is reflected from the object back into the camera. Dark field lighting uses a technique where most of the light from the light source is reflected away from the camera with the lighting usually at an angle of less than forty-five degrees or focused off the object.

19. How does backlighting work and what is it good for?

    A: Backlighting techniques provide the greatest contrast, as the light source is placed opposite the camera with the object between the two, and is great for edge detection. This method is good for inspection and measurement of certain object dimensions, determining the presence or absence of features that can be backlit (such as holes), and finding an object's location in the illumination field.

20. How can we take measurements using a laser with a vision system?

    A: If we use a laser and set up a right triangle using the laser, camera, and object as the three corners, we can triangulate the distance of the recorded light for measurement or as part of a point cloud used to create a three-dimensional image.

21. What can we do to improve a vision system's chance of finding a specific color?

    A: By using a specific wave length of light, or color, we can hide or accent features.

22. Which lighting method would be best to look inside of clear packaging to detect items?

    A: The dome diffuse lighting technique would be a good fit here as the light coming from multiple angles eliminates reflections and shadows that could otherwise cause issues.

23. What are two problems that infrared light can help to eliminate?

    A: Infrared light eliminates reflections as it is a different grey-scale value than the ambient light, thus the system ignores the reflecting ambient light in the image. This method also works well when you have multiple colored objects and you want to reduce them down to a more uniform shade.